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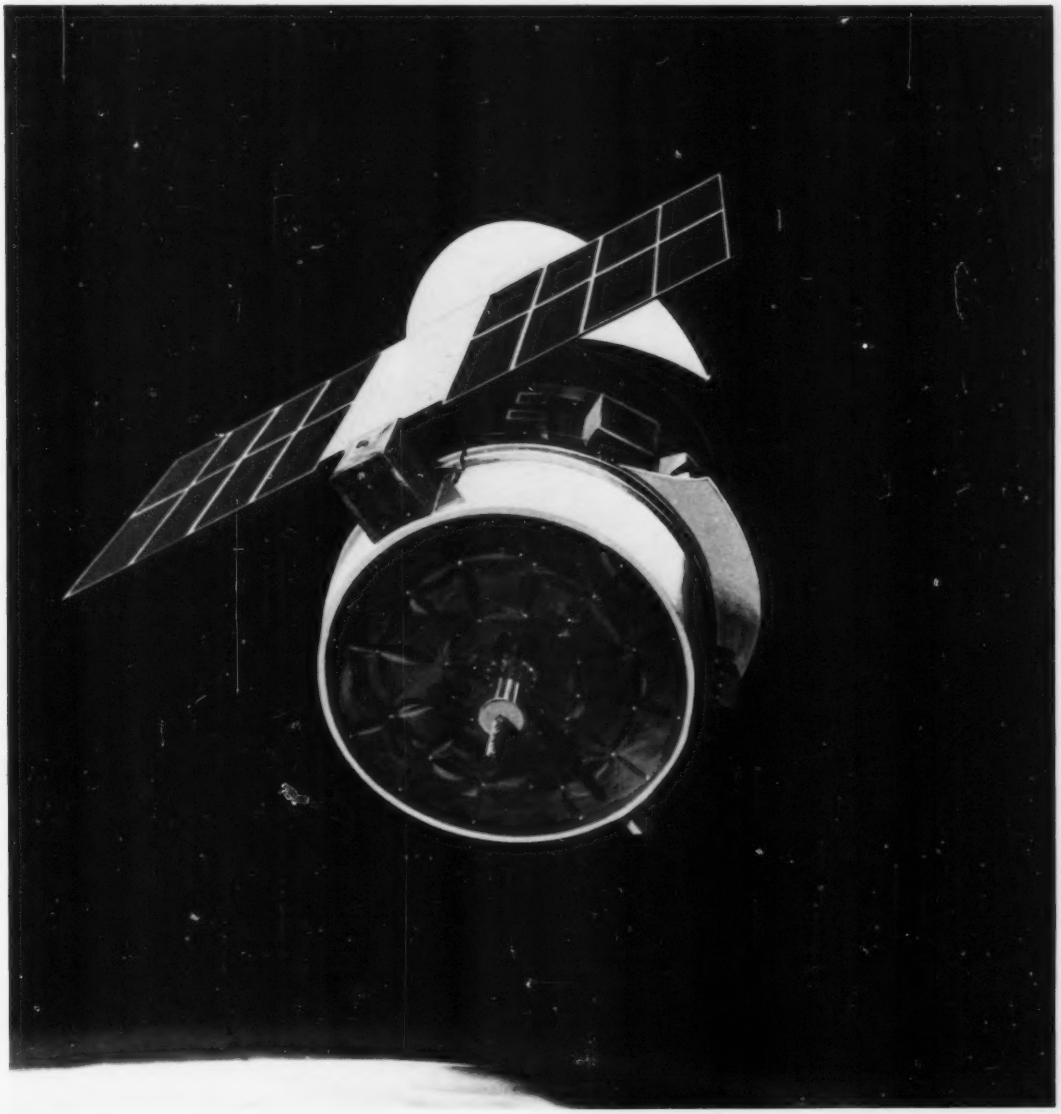

About the Cover

This month marks the anniversary of the launch of the Infrared Astronomical Satellite (IRAS), which was lifted into orbit aboard a Delta vehicle on Jan. 25, 1983, from Vandenberg Air Force Base, Calif. IRAS was a cooperative effort of the United States, the Netherlands and the United Kingdom.

IRAS racked up an impressive list of discoveries. It found seven new comets, beginning with IRAS-Araki-Alcock. It discovered three areas in which solid particles, gravitationally bound to a star, were emitting infrared energy—possibly embryonic solar systems. IRAS also found three giant dust shells around the red supergiant star Betelgeuse and three narrow rings of dust circling our own sun between the orbits of Mars and Jupiter. It uncovered enough other previously unsuspected infrared sources to impact substantially many areas of astronomy.

The satellite carried an infrared telescope, cryogenically cooled with liquid helium to 2 Kelvin (−455 F), to search the sky for objects that emit infrared radiation. IRAS was about 1,000 times more sensitive than previous sensors.

IRAS, expected to last only seven months at the time of its launch, scanned the sky for almost 10 months. On Nov. 21, 1983, it used the last of the superfluid helium refrigerant that colled its telescope and it ceased operation about a week later. Up until then, IRAS successfully surveyed 95 percent of the sky, pinpointing the locations and intensities of more than 200,000 infrared objects.

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Shuttle Mission 9—Pictorial Highlights

Crew..... John W. Young, commander
Brewster W. Shaw, pilot
Owen K. Garriott, mission specialist
Robert A.R. Parker, mission specialist
Byron K. Lichtenberg, payload specialist
Ulf Merbold, payload specialist (ESA)

Orbiter..... Columbia (OV-102)

Columbia arrival at Kennedy Space..... Nov. 23, 1982
Center (for launch preparation)

Time in Orbiter..... 10 months
Processing Facility for refurbishment and
modifications to accommodate Spacelab

Rollover to Vehicle..... Sept. 23, 1983
Assembly Building

Rollout to launch pad..... Sept. 28, 1983
Rollback to VAB for replacement..... Oct. 17, 1983
of aft assembly (due to
suspect nozzle on one of the solid
rocket boosters)

Return to launch pad..... Nov. 8, 1983

Launch date/time.... Nov. 28, 1983, 11 a.m. EST

Launch site..... Kennedy Space Center, Fla.
Launch Pad 39A

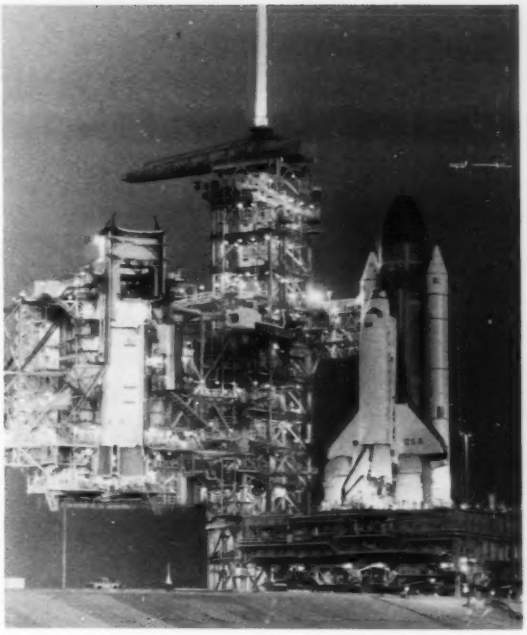
Landing site..... Edwards Air Force Base, Calif.,
Runway 17

Landing date/time... Dec. 8, 1983, 6:47 p.m. EST

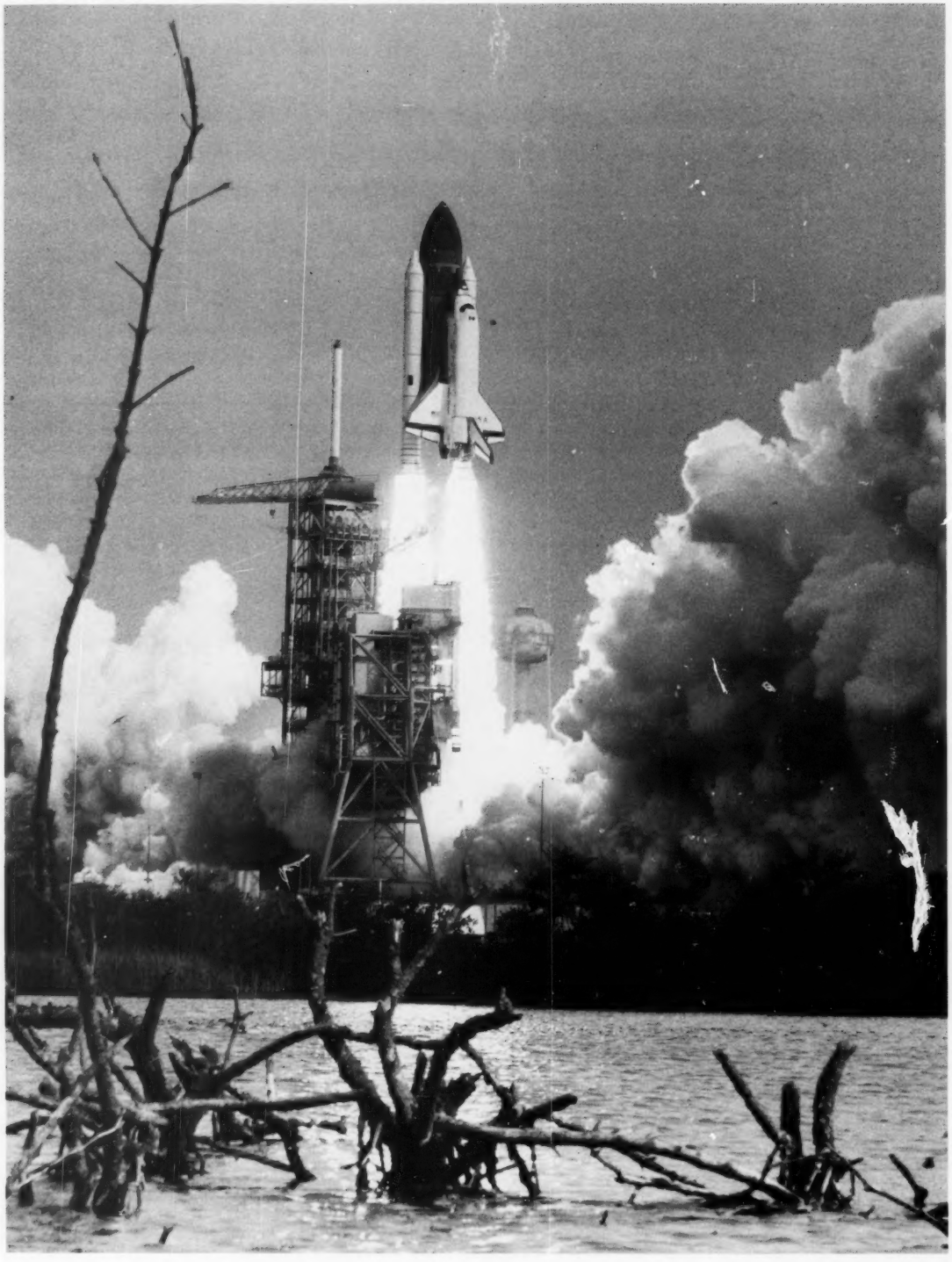
Mission duration.... 10 days, 7 hrs. 47 min., 23 sec.

Orbits..... 166 orbits; landing 167th orbit

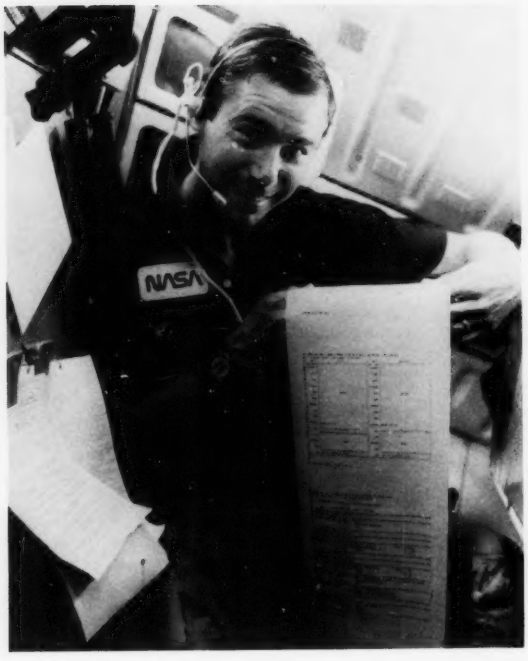
Mission firsts..... First flight of Spacelab 1
First flight of 6-person crew
First flight of a payload specialist
First flight of a non-American on
a Shuttle mission, Ulf Merbold
from Germany



The hazy light of dawn illuminates Space Shuttle Columbia as it arrives at Pad 39A following a six-hour move from the Vehicle Assembly Building. Below, STS-9 crew members at traditional pre-launch breakfast (from the left): Ulf Merbold, Robert Parker, John Young, Brewster Shaw, Byron Lichtenberg and Owen Garriott.



Garriott draws blood from Lichtenberg for later testing on earth (upper left); Merbold carries out one of the experiments using the gradient heating facility (upper right); a busy group of payload operation flight controllers follows the progress of the Spacelab 1 mission.



Garriott talks to a "ham" operator on earth via his onboard amateur radio system (upper left); Shaw displays print-out from teleprinter in the middeck (upper right); the six crewmembers position themselves in a starburst-like cluster in the aft end cone of Spacelab (left center); Young takes notes in the commander's station on the flight deck (lower left); Parker floats in the microgravity environment, participating in a biomedical test.

Columbia's rear wheels touch the ground to successfully complete its sixth and longest trip into space (above); a NASA official greets the STS-9/Spacelab 1 crew as they leave the orbiter after landing at Edwards Air Force Base in California.

ISEE–3 On First Spacecraft Flight To A Comet

The five-year-old International Sun-Earth Explorer (ISEE-3), directed on a daring new mission by NASA's Goddard Space Flight Center in Greenbelt, Md., swooped 120 kilometers (75 miles) above the moon's surface on Dec. 22, 1983. The lunar swingby catapulted the spacecraft, toward oncoming comet Giacobini-Zinner, for the first spacecraft encounter with a comet.

ISEE-3 (renamed International Cometary Explorer (ICE)—is scheduled to pass through the tail of Giacobini-Zinner on Sept. 11, 1985 at a distance from the comet's head of about 15,000 km (9,300 mi.). (The exact distance will be determined while the spacecraft is en route to the comet.)

The aging spacecraft—the first ever to be redirected from the earth-moon region for a new mission into interplanetary space—will provide a low-cost exploration of the comet's tail and its relation to the solar wind.

ICE will reach Comet Giacobini-Zinner about six months before five probes from the U.S.S.R., the European Space Agency, and Japan visit Halley's comet to study its nucleus, the surrounding gas and dust, and their interaction with the solar wind.

ICE, launched Aug. 12, 1978 to study the sun and its interaction with the earth, successfully completed its original mission in 1982, and the first phase of its new mission in the earth's geotail in 1983.

That makes ICE's new mission one of NASA's best science bargains ever. Dr. Robert Farquhar, the Goddard flight director who conceived the second use for the spacecraft, estimated the additional cost at just $3 million to $5 million. "This compares with some $200 million for new, dedicated spacecraft to do the same work," he noted.

Dipping low over the moon in the region of Smyth's Sea, and passing not far from Tranquility Base, ICE picked up speed and was redirected by the moon's gravitational pull to escape from the earth-moon system. This tricky maneuver required the closest pass of the moon ever attempted.

"This is the decisive moment for ICE," said Farquhar who directed the orbital maneuvers. "It's tricky because flying 120 km over the moon's surface does not leave much margin for error in navigating the spacecraft."

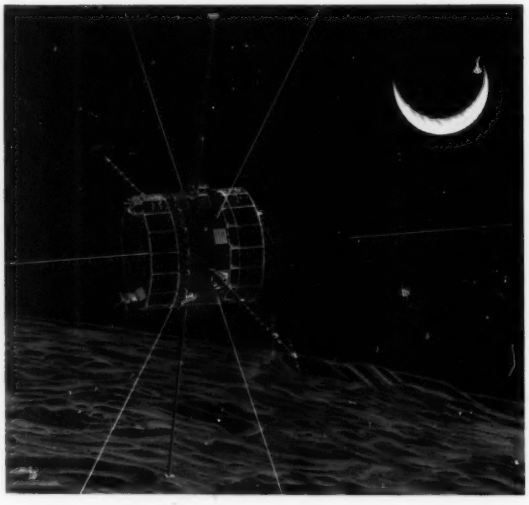
The close fly-by on Dec. 22 was essential for picking up sufficient speed and the necessary direction to reach comet Gaicobini-Zinner almost 21 months later on Sept. 11, 1985. At that time the spacecraft and the comet will be almost 70 million km (44 million mi.) from the earth and about 155 million km (96 million mi.) from the sun. The comet, discovered in 1900, makes one orbit around the sun every six-and-a-half years.

"Our single most important scientific objective," says ICE Comet Scientist Dr. John C. Brandt of Goddard, "is to penetrate the tail of the comet and make the first direct measurements of its important features." These features include the magnetic fields which define the tail's shape and the plasma of electrified gases which make up its content.

Equally interesting to scientists is how the comet interacts with the solar wind, the flow of charged particles and energy streaming from the sun outward through the solar system.

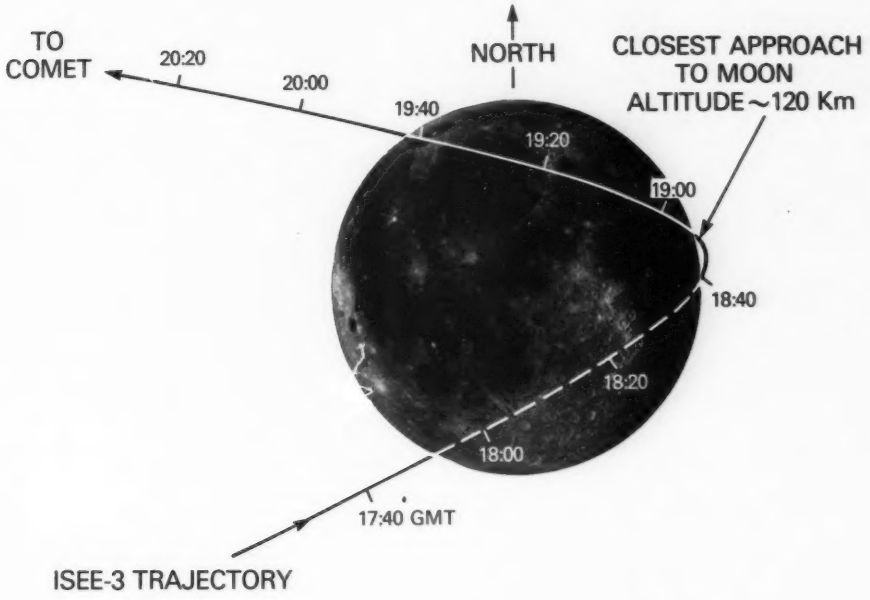
As the spacecraft approaches the comet, NASA will determine the optimum location for the single pass through the tail. "My present guess," says Brandt, "is that we would get the best data if we aim for 15,000 km (about 9,300 mi.) behind the head of the comet, but we can steer much closer to the head if we need to."

To reach comet Giacobini-Zinner, Goddard controllers are relying on astronomers at ground observatories to photograph the comet so that its orbit can be repeatedly updated. The orbit is expected to deviate slightly from that based on predictions from previous appearances as the comet has responded to gravitational tugs from the planets. Additionally, the comet may be jarred off course by jets of evaporating gas streaming from its nucleus.



NASA's ICE spacecraft streaks just 116 km (72 mi.) above the lunar surface Dec. 22, 1983, as it is catapulted by the moon's gravity toward a Sept. 11, 1985, encounter with comet Giacobini-Zinner.

TRAJECTORY OF ISEE-3 AROUND THE MOON AS SEEN FROM THE EARTH



After intercepting Giacobini-Zinner, ICE will continue through interplanetary space to investigate solar wind disturbances that might affect Halley's Comet: first in October 1985 and again in March 1986.

The spacecraft will observe conditions in the solar wind upstream of Halley's Comet from a distance of 138.4 million km (86 million miles) on Oct. 31, 1985 and from a distance of 30.5 million km (18.9 million miles) on March 26, 1986. (Upstream means that ICE will make measurements of the solar wind between the sun and Halley's Comet.)

Scientists will use at least six of the scientific instruments aboard ICE to study Giacobini-Zinner's tail and conditions in the solar wind. These are a magnetometer, a plasma electron analyzer, an ion composition experiment, a set of three charged particle telescropes, a plasma wave detector, and a radio wave spectrometer. Additionally, experimenters are looking at uses for other instruments aboard the spacecraft.

By the time the comet exploration mission ends, ICE will have completed the most complex set of trajectory modifications ever attempted by a NASA spacecraft. The maneuvers to visit Comet Giacobini-Zinner and then study the solar wind upstream of Halley's Comet will be just the latest in a series of complex orbital gymnastics performed by the spacecraft since it was launched in August 1978.

To study the interplanetary medium between the earth and sun, ICE's first assignment, the spacecraft became the first ever to orbit a libration point rather than a physical body such as a planet. A libration point is a location in space where an object would remain gravitationally fixed with respect to the sun and earth-moon system. ICE was located near one of these points designated L1.

Orbiting L1, the spacecraft was suspended in equilibrium between the sun and the earth-moon system, measuring the solar wind as it flowed toward earth, and performing other scientific observations. The spacecraft has outlived its expected mission life of three years, remaining in good condition, with about 70 percent of its propellant reserves remaining.

On June 10, 1982, initiating a daring second life for the spacecraft, Goddard flight controllers directed ICE away from its libration point orbit on a new four-year mission that will culminate with the cometary intercept.

The new mission began with an extended exploration of conditions in the earth's magnetic tail to learn how plasmas and magnetic field structures behave at great distances from the tail. The tail is part of the earth's

magnetosphere which, deformed by the force of the solar wind flowing from the sun, extends far behind the planet.

Exploring the earth's magnetic tail region required ICE to repeatedly change orbits and direction so that it could sample conditions at varying distances behind the earth. The maneuvers included four lunar swingbys at distances of some 20,000 km (about 12,000 mi.) from the moon, and enabled scientists to map previously unexplored regions along the length of the tail. The tail exploration concluded in October 1983.

According to Goddard Project Scientist for the mission, Dr. Tycho von Rosenvinge, ICE also will demonstrate a valuable new capability for future NASA missions. "By accepting the challenge of investigating a scientific opportunity with a used spacecraft," he notes, "NASA has taken a new, and more flexible attitude in place of the usual 'one spacecraft one mission' practice. The could feed directly into the design of future scientific spacecraft."

New Publications Issued on Air and Space

(NASA SP-459) *Antarctic Sea Ice Atlas, 1973-1976: Satellite Passive-Microwave Observations,* has been published by NASA's Scientific and Technical Information Branch and Goddard Space Flight Center.

The publication summarizes Antarctic sea ice cover observed by Nimbus 5 over a four-year period.

While it is primarily intended to be a useful reference for climatologists and cryospheric scientists, it is also interesting reading for a technically educated audience. Data are presented in the form of color maps of the Antarctic and southern oceans.

The book was coauthored by H.J. Zwally, Josefino C. Comiso, Claire Parkinson, and Per Gloersen of Goddard, William J. Campbell of the U.S. Geological Survey, and Frank D. Carsey of NASA's Jet Propulsion Laboratory.

The book may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $21.00.

Two new books, published by the Smithsonian Institution Press are available:

The First 25 Years in Space: A Symposium, provides a variety of commentaries on these first momentous decades.

The volume is based on a daylong symposium sponsored last year by the Smithsonian's National Air and Space Museum and the National Academy of Sciences. However, the book is not merely a proceedings, but a thought-provoking collection of essays discussing some of the most important issues of our time.

The 208-page publication is divided into three sections: the first addresses the motivations for going into space and how those motivations have changed during the past 25 years; the second focuses on the economic significance of space activities and suggests how these activities might be organized, managed and supported in the future, and the third section explores the scientific reasons for venturing into space.

Each section ends with an edited version of the often-lively discussion that followed the individual presentations.

The volume, certain to be of interest to those curious about space exploration as well as to historians, combines a wide-ranging sample of informed opinion and expertise with first-person accounts of significant events during the past 25 years.

The book was edited by Allan Needell, associate curator, Space Science and Exploration Department, National Air and Space Museum.

The First 25 Years in Space: A Symposium is available for $12.50 in hardback from the Smithsonian Institution Press, P.O. Box 1579, Washington, D.C. 20013. Postage and handling is $1.50 for the first copy and 50 cents for each additional copy.

A new catalog entitled *Rockets, Missiles, and Spacecraft of the National Air and Space Museum,* contains brief descriptive articles by museum staff members about the items currently on display, plus a listing of American-flown manned spacecraft and where they are located. Included with each entry are historical photographs and artifact specifications.

The museum's rockets, missiles and spacecraft tell the complete story of the U.S. space program. Through a unique agreement with the National Aeronautics and Space Administration, in effect since 1967, the museum is sole custodian of all relics pertaining to American space exploration. These items are on display at the museum or its Paul E. Garber Facility, loaned to other museums or preserved in storage.

The catalog, compiled by Gregory P. Kennedy, assistant curator in the museum's space science and exploration department, is revised from the original 1976 edition.

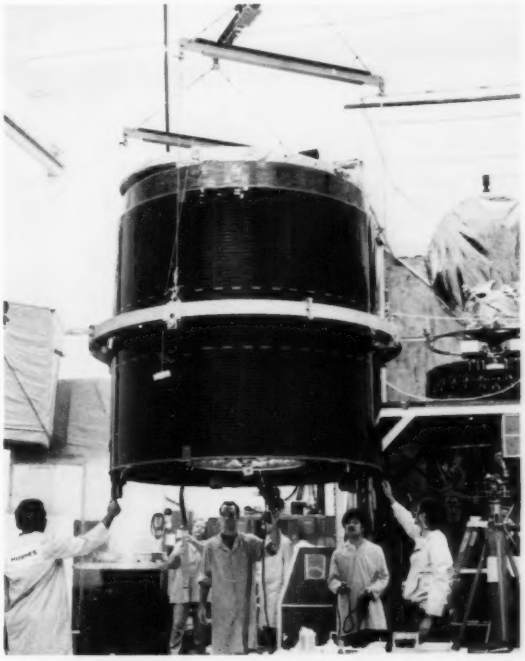
It is available for $6.50, in paperback only, from the Smithsonian Institution Press, P.O. Box 1579, Washington, D.C. 20013. Postage and handling is $1.50 for the first copy and 50 cents for each additional copy.

Shuttle Mission 41-B—Pre-Launch Statistics

Crew	Vance D. Brand, commander Robert L. Gbson, pilot Bruce McCandless II, mission specialist Robert L. Stewart, mission specialist Ronald E. McNair, mission specialist
Orbiter	Challenger (OV-099)
Launch site	Kennedy Space Center, Fla., Pad 39A
Launch date/time	Feb. 3, 1984* 8 a.m. EST
Altitude	165 miles
Orbital inclination	28.5 degrees
Mission duration	7 days, 23 hours, 19 minutes*
Landing date/time	Feb. 11, 1984, 7:19 a.m. EST*
Landing site (weather alternate)	Kennedy Space Center, Fla. Edwards Air Force Base, Calif.
Mission firsts	First flight Manned Maneuvering Unit First extravehicular activity with no extended pre-breath First orbiter rendezvous using onboard navigation and sensors First use of manipulator foot restraint First KSC landing
Principal cargo	Palapa B-2 (Indonesian satellite) Westar-VI (Western Union Satellite) Shuttle Pallet Satellite (SPAS-01A) Integrated Rendezvous Target
Experiments	Shuttle Student Involvement Project Isoelectric Focusing Experiment Monodisperse Latex Reactor Acoustic Containerless Experiment System Five Getaway Special containers

* Subject to change; mission elapsed times are approximate.

Shuttle mission 41-B crew—Front row: Vance D. Brand, commander; and Robert L. Gibson, pilot. Mission specialists (back row, left to right) are Robert L. Stewart, Dr. Ronald E. McNair and Bruce McCandless II. Below, technicians make adjustments to the Palapa B-2 spacecraft prior to encapsulation and final checkout. The satellite will be deployed from orbiter Challenger on mission 41-B scheduled for Feb. 3, 1984.



Principal mission activity:

Flight Day 1
Cinema 360 heater activation
Monodisperse Latex Reactor
Westar-VI deployment

Flight Day 2
Acoustic Containerless Experiment
Isoelectric Focusing Experiment
Handheld Radiation Monitor/Pocket Radiation Meter
Cinema 360
Palapa B-2 deployment
Monodisperse Latex Reactor activities
SPAS-01A activities
Animal Enclosure Module

Flight Day 3
Integrated Rendezvous Target operations
Getaway Special activities

Flight Day 4
Handheld Radiation Monitor
Rendezvous/proximity operations
Integration Rendezvous Target separation
SPAS-01A operations
Getaway Special activities

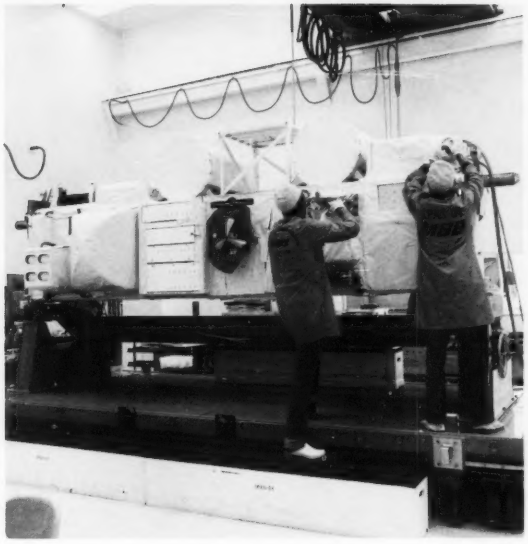
Flight Day 5
Remote Manipulator System powerup
Extravehicular activity
SPAS-01A operations

Flight Day 6
Animal Enclosure Module
SPAS-01A operations
Cinema 360
Getaway Special activities

Flight Day 7
Getaway Special activity
SPAS-01A operations
Cinema 360
Extravehicular activity
Animal Enclosure Module

Flight Day 8
On-orbit press conference
Getaway Special activity

Flight Day 9
Landing



SPAS-01A is readied for its second trip into space on flight 41-B. The West German payload holds eight experiments and will be lifted out of Challenger's cargo bay by the Remote Manipulator System for a practice simulation of the retrieval and repair of the disabled Solar Maximum Mission spacecraft. Below, mission specialist Bruce McCandless tests the placement of the hardware for the Manned Maneuvering Unit. The jet backpack will be used for the first time in space on Shuttle flight 41-B.

SAM II Instrument Providing Environmental Information

SAM II (Stratospheric Aerosol Measurement II), a NASA satellite instrument, has been methodically measuring earth's atmosphere for five years, providing scientists with large amounts of information about the stratosphere, particularly in the polar regions. Some of the data have helped verify existing scientific theories, but other information has been quite surprising.

"Among many achievements, SAM II has provided excellent data on volcanic activity," according to Dr. M. Patrick McCormick, SAM II science team leader at NASA's Langley Research Center in Hampton, Va. "The data clearly show the buildup of aerosols in the stratosphere's polar regions and, therefore, provides scientists with the necessary data to study the climatic effects of recent volcanic eruptions."

Increased volcanic activity, as from the 1982 eruption of El Chichon in southern Mexico that put huge amounts of sulfur dioxide into the stratosphere, is in direct opposition to the "greenhouse effect" in the atmosphere. That effect is caused when large amounts of carbon dioxide, concentrated in the lower atmosphere, tend to prevent earth's heat from dissipating into space.

Global volcanic clouds, however, laced with sulfuric acid (created when sulfur dioxide condenses), reflect the sun's radiation back into space, thereby depriving the lower atmosphere and earth's surface of some radiation and tending to cool the surface.

One could almost argue that more volcanic accumulation in the stratosphere will help to balance earth's radiation budget by counteracting the carbon dioxide effect: icehouse versus greenhouse.

The most surprising SAM II finding to date also represents a rapid commercial spinoff of NASA research. In late 1982, airline people throughout the world began to notice that the acrylic windows in some of their larger aircraft were being mysteriously clouded over with minute cracks. They discovered that the damage, called crazing, occurred on those planes that flew polar routes. Routine cruising altitudes of 30,000 to 35,000 feet become stratospheric in the polar regions, where the stratosphere dips closest to earth's surface.

The airlines blamed the aircraft manufacturers, who blamed the window makers, who swore their innocence. During the growing tension and frustration, one aircraft company manager called NASA-Langley for possible help. Evidence from SAM II showed that volcanically produced sulfuric acid in the stratosphere was causing the window crazing. To help solve the problem, McCormick is now an adviser to a task force of air transport operators.

SAM II is also providing scientists with data on the length of time stratospheric volcanic debris from a point source takes to arrive at the polar regions. This information is important in understanding stratospheric transport and dispersion, and is obviously relevant to the global consequences of possible nuclear detonations.

SAM II data are providing better understanding of the dynamics of vortex activity in the polar regions. An aerosol data base provided by SAM II is used as a tracer for stratospheric motions, and an aerosol "ledge" can be clearly seen at the boundary of vortexes of cold polar air.

The Langley researchers are also pleased with SAM II's discovery of ice clouds in the polar stratosphere near 60,000 feet. "We named them," McCormick said with pride. "They are called PCSs, for Polar Stratospheric Clouds, and we published the first quantitative data on the phenomenon and on its formation mechanism."

Nacreous (pearl-hued) clouds have been sporadically sighted through the years in the winter months by observers on earth. The clouds were thought to occur at around 70,000 feet under specific meterological conditions. SAM II found that PSCs occur much more frequently than the scattered visual sightings reflect; during its first two years of operation, SAM II measured more than 1,000 PSCs. The researchers have concluded that the nacreous clouds are probably a sub-element of PSCs.

SAM II was launched into polar orbit aboard the Nimbus 7 satellite Oct. 24, 1978, from NASA's Western Test Range near Lompoc, Calif. Nine scientific instruments were aboard, all designed to study natural and manmade pollutants in earth's atmosphere and oceans. The Nimbus program is managed at NASA's Goddard Space Flight Center, Greenbelt, Md.

Some of the Nimbus instruments have stopped operating, but SAM II has steadily sensed, collected and dispatched to earth more than 50,000 profiles to date on aerosol concentration in the lower atmosphere.

Another SAM II accomplishment is the set of polar aerosol data that is being analyzed and archived by Langley researchers. The data set, the first of its kind, is used to study the spatial and temporal variations in aerosol concentration, its impact on weather and climate and their long-term trends.

NASA Reshapes Turboprops To Extend Fuel Saving

In an effort to improve the fuel efficiency of future aircraft, NASA propulsion researchers are taking the turboprop of the 1950s and 1960s and reshaping it for the 1980s and beyond.

The new turboprop—a cross between early propeller concepts and the turbofan engines of modern jet transports—is evolving from NASA's Aircraft Energy Efficiency program studies begun in response to the 1973 oil embargo and sharply rising fuel prices. These studies identified possible aeronautical propulsion technology having a combined potential for improving the fuel efficiency of future aircraft by 50 percent.

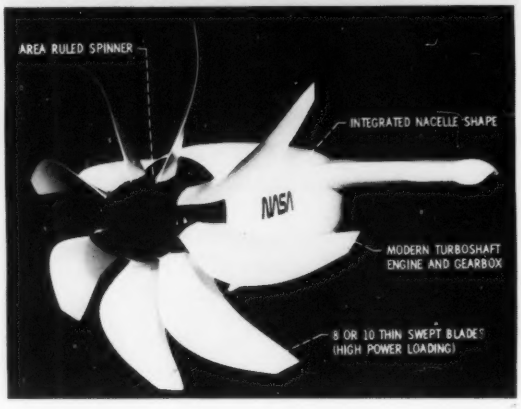
Numerous studies and subscale tests of advanced turboprop concepts verified the turboprop's potential to provide a fuel savings of 15 to 30 percent. The advanced turboprops were especially designed to absorb more power and to maintain efficiency up to conventional, subsonic turbofan cruise speeds. At intermediate flight ranges, fuel savings of 15 to 20 percent were identified. Fuel savings were even larger at the long and short flight ranges, reaching 25 to 30 percent for the short routes.

These test results make the advanced turboprop look particularly attractive for short/medium haul markets currently served by the DC-9 and the Boeing 727 and 737 aircraft which have capacities of 120 to 150 passengers. Extending propeller efficiency for flight at the higher speeds of modern jet transports is a major technological hurdle today.

For example, an aerodynamic effect known as "compressibility" limits the speed at which conventional propellers can operate efficiently. Working with the propeller industry, researchers at Lewis Research Center in Cleveland have taken advantage of several technology advances in propeller blade structure and aerodynamics to dramatically reshape the propeller and thereby delay the onset of compressibility effects.

The researchers' design for an advanced turboprop propulsion system consists of eight or 10 highly swept blades that are about one half as thick as conventional propeller blades on a single engine shaft. Reducing blade thickness and providing blade sweep at the tips delays the onset of compressibility effects and the attendant drag rise and noise-producing supersonic shock waves. The increased number of these highly "loaded" blades helps keep propeller diameter to a reasonable size and weight. New materials and construction techniques allow the blades to be shaped

ADVANCED TURBOPROP PROPULSION SYSTEM


AREA RULED SPINNER
INTEGRATED NACELLE SHAPE
NASA
MODERN TURBOSHAFT ENGINE AND GEARBOX
8 OR 10 THIN SWEPT BLADES (HIGH POWER LOADING)

for near optimum aerodynamic efficiency for flight over the entire speed and altitude range of modern jet transports.

Other technological challenges for the turboprop include engine noise and vibration for passenger comfort, finding the most aerodynamically efficient mating of the engines to the airframe and reducing propeller and engine gearbox maintenance. The newly-shaped, thin, highly swept turboprop blades may lower the noise and vibration levels enough to reduce acoustic treatment weight in the aircraft cabin walls.

In conventional aircraft, the weight of noise absorption materials can be as high as 3,630 to 4,540 kilograms (8,000 to 10,000 pounds) for a medium sized, medium range transport. If propeller noise could be reduced by 10 decibels and improved acoustic treatment could be used, the weight penalty could be as low as 680 kg (1,500 lb.). Reducing aircraft weight also reduces fuel consumption.

The efficient mating of propeller engine and airframe is being accomplished primarily through installation aerodynamic analysis and wind tunnel tests at NASA's Ames and Langley Research Centers. Considerable effort is devoted to straightening the swirling air streaming from the propeller to achieve maximum propeller thrust and reduce air drag. If unchecked, the interference drag could seriously compromise the fuel savings of the turboprop with its large, exposed propeller system.

NASA plans to award a contract next year to an American airframe manufacturer for research leading to high speed flight tests of a large-scale advanced turboprop. Scheduled for early 1987, the tests will involve mounting a single advanced turboprop on the wing of an existing transport. The flight tests, designed

to prove the system's fuel economy and reliability, will offer the first comprehensive large-scale tests of advanced turboprop structural integrity, propeller near- and far-field noise, and cabin noise and vibration.

Meanwhile, NASA continues to work on improved propeller designs, including contra-rotating propellers, cabin noise reduction, installation aerodynamics and alternative configurations, including aft-mounted and pusher propeller arrangements.

NASA Takes First Steps Towards Flying Civilians In Space

NASA has filed with the Federal Register a proposed rule setting in motion the machinery to fly the first civilian passenger on the Space Shuttle.

The proposed rule is the first step to establishing policy and tentative selection procedures to carry citizen observers/participants on future Shuttle flights. It would establish procedures and guidelines for the eventual acceptance of applications from individuals meeting certain criteria, still under review.

A 60-day comment period will follow publication of the proposed regulation. NASA then will have another 60 days to incorporate possible changes or additions to the rule.

A task force of the NASA Advisory Council with John E. Naugle as chairman had studied the issue of civilian flight on the Shuttle and in its report to NASA Administrator James M. Beggs had recommended in part that "NASA should take the next step in opening space flight to all people by flying observers for the reason of meeting the purposes of the Space Act."

The regulation will establish a Citizen Observer/Participant Evaluation Committee at NASA Headquarters to manage the selection process.

It also sets up basic guidelines for applicants, such as health, training and space adaptability.

Applicants will be evaluated by a NASA-designated outside review panel, with the agency retaining authority for final selection.

Flight opportunities will be announced by NASA through notice in the Federal Register and other public means through the media.

No applications will be received at this time, but comments about the rule should be addressed to: Associate Administrator for External Relations (Code L), NASA Headquarters, Washington, D.C. 20546. The public may examine such comments in Room 125, FB-10B, 600 Independence Ave., SW, Washington, D.C.

NASA Techniques Lead To Improved Medical Diagnosis

A new use of nuclear magnetic resonance (NMR) technique has the potential to allow doctors to view the inner parts of the body in color and in detail—without using dangerous radiation.

The potential for combining NASA-developed image processing technology with this dramatic new application of diagnostic NMR just might advance medicine as far as the use of X-rays did.

Now being studied at many university medical institutes such as the Mallinckrodt Institute of Radiology at Washington University Medical School in St. Louis, NMR uses a powerful magnetic field and radio waves instead of possibly dangerous X-rays. A patient is placed inside a large magnetic coil and the magnetic field is turned on. The magnetic field affects the atoms in certain molecules (for example, water) and causes them to align themselves with the magnetic field lines. The effect is similar to the familiar demonstration of iron filings lining up on a sheet of paper held over a magnet.

With the molecules aligned, a field of radio energy is beamed through the patient, causing a slightly different alignment.

When the radio waves are then abruptly turned off, the water molecules attempt to swing back into their magnetic alignment, but oscillate like a pendulum before they reach a steady state again. This oscillation causes extemely weak radio signals to be created.

By receiving and analyzing these weak signals, the NMR machine can obtain information about the molecules. At least three different types or channels of information can be received by the machine.

As demonstrated by NASA, a given electronic image can be computer processed to enhance a specific characteristic, sharpen contrast, remove confusing details or be improved in other ways. Using this ability, the Landsat satellite system has successfully located valuable timberstands, mineral depsoits, petroleum sources and rich fishing grounds. The process has been greatly developed by NASA's Jet Propulsion Laboratory, Pasadena, Calif., and the well-known results are the spectacular views of Jupiter and Saturn from the Voyager spacecraft, and of Mars from the Viking probes.

Three or four channels of digital information are usually combined in the computer to obtain enhanced images. Significantly, these channels of data are not very different from the type of data obtained from certain medical tests.

Recognizing this key similarity, Dr. Michael Vannier of Washington University called on NASA in 1980 to see if computer processing techniques developed for satellite images could be applied to medical imagery. The request reached the attention of Bob Butterfield, Kennedy Space Center's Manager of Technology Integration.

Butterfield responsed enthusiastically and made a brief trip to Washington University to see what kinds of equipment Vannier was using and what types of imagery might be involved. Finding some very good but modest image processing equipment and techniques being utilized, Butterfield invited Vannier to Kennedy to process test data on NASA's more sophisticated machines.

Even the initial results "saved three years of effort that would have been needed using our own equipment," according to Dr. Vannier. He was able to determine the prospects for image processing, what could be done and what could not be done—without extensive and expensive independent effort.

"That's just exactly what NASA's Technology Utilization programs are designed to accomplish," said Butterfield. "Our purpose is to transfer the results of our research to applicable areas of industry and the public."

To analyze an NMR image, the image processing operator designates a small region of interest on the digital image. The computer then searches the image to extract information from each channel which matches preset levels. With the "signature" of each channel thus extracted, the computer can adjust each signature, sharpening detail and reducing the amount of ambiguity between signatures.

Each channel's synthetically sharpened signature can then be reassembled into a theme map, using colors defined by the operator. The result can be a cross sectional picture of the area with selected characteristics (such as tumors) amplified, or a near-real-color image of the area.

Future computer manipulation may result in the narrow slices of NMR imagery being combined into three-dimensional views. What would appear on the screen would be a three-dimensional construct of almost any portion of the body, viewed from any angle, or even from the inside.

While the ultimate potential for NMR imaging can only be guessed at, pioneers in the field such as Dr. Vannier say that is is very likely that the technique could advance medicine as much or more than X-rays have.

Finally, if image processing technology is a "spinoff" from NASA research, advanced diagnostic technologies may be a "spinback" from medicine. According to Butterfield, NASA is finding that a technology like CT and NMR may present new methods for non-destructive testing which better previous techniques.

European Space Agency Receives Spacelab Painting

An oil painting, *SPACELAB 1*, by artist Charles Schmidt was presented to European Space Agency Director-General Eric Quistgaard by NASA Administrator James M. Beggs at a prelaunch reception, Nov. 27, 1983, at Kennedy Space Center, Fla.

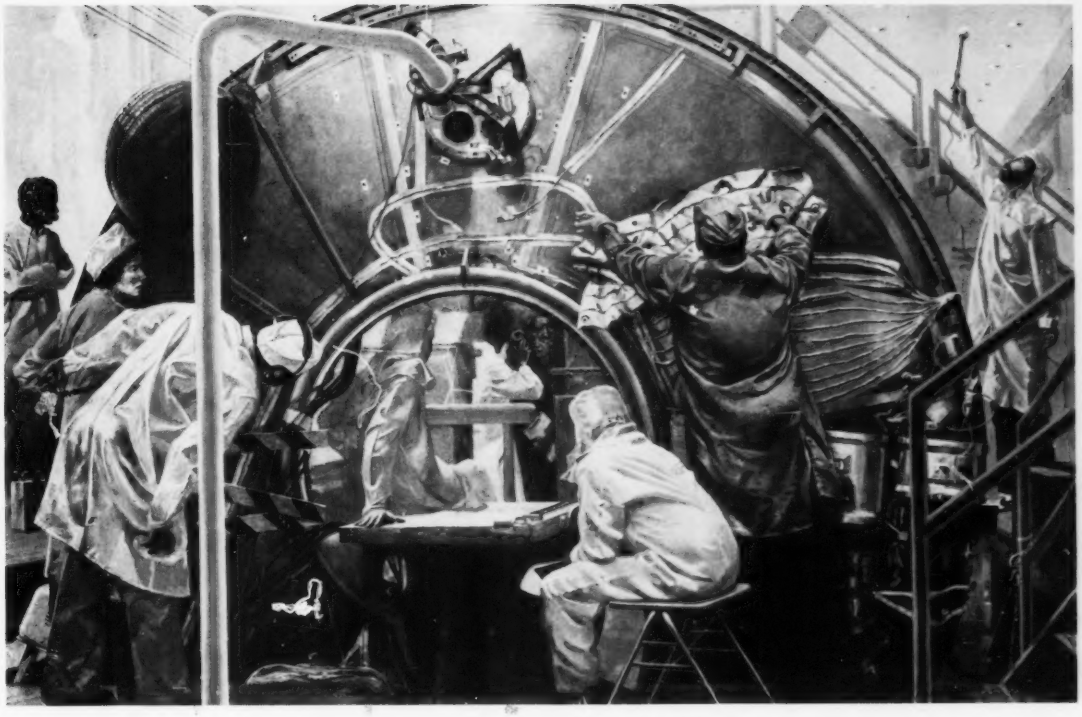
Spacelab, built and paid for by ESA, is a versatile modular facility carried in the Space Shuttle orbiter. It represents a European investment of approximately $1 billion. The Nov. 28 launch of Spacelab 1 represents a significant international cooperative effort between ESA and NASA. NASA is responsible for the launch and operational use of Spacelab.

The 52-by-72-inch painting, *SPACELAB 1*, depicts NASA and ESA astronauts and technicians at work on the scientific laboratory during mission sequence tests. The painting was developed from drawings made by the artist in the Operation and Control building at the Kennedy Space Center in the spring of 1983 when the laboratory was undergoing mission sequence tests.

Schmidt, a 44-year-old Pennsylvanian, has several prizes and shows to his credit and his work has appeared in American Artist, Look, Aviation Week And Space Technology and Discover magazines.

Last year, as part of the NASA Art Program, Schmidt did a painting documenting the Spacelab 1 payload integration. He also was a member of the NASA art team assigned to the first and third Space Shuttle launches. Most of the paintings he has done for NASA are currently in a two-year national touring exhibition, "The Artist and the Space Shuttle," which was shown first at the National Air and Space Museum in late 1982.

Currently, Schmidt is a professor of painting and drawing, Tyler School of Art at Temple University in Philadelphia. From 1963-65, he was an instructor of drawing at Atlanta College of Art. From 1961-62, Schmidt was a White House calligrapher.



Spacelab 1, an oil painting by Charles Schmidt, was especially commissioned to present to the European Space Agency for exhibition in Paris.

Contractor News

Marshall Space Flight Center, Huntsville, Ala., has selected **Management Services, Inc.,** Huntsville, Ala., for negotiations leading to award of a new five-year contract to provide institutional mission services at the center. Total cost and fee for the contract over the first year basic period and two price option years is approximately $16.6 million. The contractor will furnish the necessary management, personnel, facilities and equipment required to provide services in the areas of vehicle and equipment operations and maintenance; documentation repository; graphic arts, models and exhibits; and supply and equipment management.

Marshall has also awarded a two-year $14.8 million contract to the **Linde Division of Union Carbide Corp.,** Danbury, Conn., for liquid hydrogen to meet the requirements of NASA activities on the west coast of the United States. The period of the fixed-price contract is Jan. 1, 1984, through Dec. 31, 1985. Actual work will be performed at Linde Division facilities in Fontana, Calif. Marshall is responsible for the procurement of liquid hydrogen for all U.S. government agencies throughout the United States. This particular contract provides for liquid hydrogen for use by Ames Research Center, Mountain View, Calif., and its Dryden Flight Research Facility at Edwards Air Force Base, Calif., as well as other west coast NASA users.

Lewis Research Center, Cleveland, Ohio, has definitized a letter contract with **General Dynamics, Convair Division,** San Diego, Calif., for $70,356,500 for four Atlas/Centaur launch vehicles to support future missions for the Atlas/Centaur program. The fixed-price-incentive contract is for fabrication, assembly and test of the four launch vehicles. Most of the work, initiated last year under a letter contract, is being performed at the contractor's plant in San Diego. The contract will be in effect through October 1985. Centaur, the nation's first high-energy, liquid hydrogen-liquid oxygen rocket vehicle, is used as a second stage in a combination Atlas/Centaur vehicle.

NASA Lewis has also awarded two contracts in support of the NASA/Department of Defense Shuttle/Centaur program. An $8,376,750 cost-plus-incentive-fee contract for fabrication, assembly, test and delivery of four RL10A-3-3B rocket engines for modified Centaurs was awarded to **United Technologies Corp., Pratt & Whitney Aircraft Group, Government Products Division,** West Palm Beach, Fla. Work is to be performed at the contractor's West Palm Beach plant. The contract will be in effect through February 1986.

The second award is a $5,275,600 cost-plus-incentive fee/award-fee contract for additional guidance systems for modified Centaur launch vehicles to **Honeywell, Inc., Avionics Division,** Clearwater, Fla. Work is to be performed at the contractor's plant in Clearwater. The contract is to be in effect through January 1986. Centaur is a high-energy upper stage launch vehicle which, when modified, will be used in conjunction with the Space Shuttle for delivering heavier payloads to high orbit or into interplanetary trajectories for NASA as well as the Air Force.

Kennedy Space Center, Fla., has awarded **Planning Research Corp. Systems Services Co./Briel, Rhame, Poynter & Houser** (a joint venture) of Cocoa Beach, Fla., a $4,250,000 million contract for architectural and engineering services during the construction and activation of Launch Pad 39B. The fixed-price contract, initiated Dec. 1, 1983, extends to Feb. 1, 1986. This action is the result of a modification to an existing contract originally initiated in December 1982 and brings the total value of the original contract to $14,433,321. The contract provides surveillance, estimation, inspection, test monitoring, schedule coordination, integration, report and status preparation services in support of modifications to Pad 39B. Launch Pad 39B is scheduled to be used for the first time in 1986. Pad B will supplement Pad A and provide launch flexibility for the Space Transportation System.

Goddard Space Flight Center, Greenbelt, Md., has selected **EG&G, Washington Analytical Services Center, Inc.,** of Rockville, Md., for negotiation of a cost-plus-award-fee contract for scientific data analysis and computer programming support to the center's Applications Directorate in the area of geodynamics. The contract, effective Jan. 2, 1984, consists of a three-year basic period of performance with one two-year soft option. The estimated cost and fees for the basic and options periods are $4.4 million and $3.6 million, respectively.

Orbiter Enterprise To Be Shown At New Orleans Exposition

The Space Shuttle orbiter Enterprise will be on display at the Louisiana World Exposition to be held in New Orleans from May 12 to Nov. 11, 1984.

In a letter to Petr Spurney, President of the Louisiana 1984 World Exposition, Inc., NASA Administrator, James M. Beggs, stated, "Following a comprehensive examination of the logistical problems and probable costs involved, we are convinced that it is feasible to transport the Space Shuttle Enterprise to New Orleans and to make it available for display at the 1984 Louisiana World Exposition."

Beggs said the request to display the Enterprise was approved based on an agreement with Exposition management that the fair will pay for round trip overland transportation of the Enterprise as well as any costs connected with its display at the fair.

NASA said the Enterprise will be flown from its present location at Edwards Air Force Base, Calif., on top of its specially-modified 747 carrier aircraft to a location where it could be unloaded and made ready for its trip to New Orleans.

Preliminary planning by transportation experts indicate that the most likely transfer sites are at NASA's Marshall Space Flight Center at Huntsville, Ala., or at an air force base at Mobile, Ala. Both locations would permit unloading the 68,000 kilogram (150,000 pound) orbiter on a barge for water transport to the fair site on the east bank of the Mississippi River.

Fair officials stated they are so sure that the Enterprise would be a major attraction at the 1984 Exposition that they are willing to arrange funding needed to move the spacecraft to New Orleans and prepare it for display.

A great deal of study and work is needed by both the fair management and by NASA before a final detailed agreement will be reached, but NASA is serious in its intention to display the Enterprise at the fair. Beggs noted, "We at NASA are very much aware of the potential benefits for the agency, for the Space Program and for our nation which can result from exposure to an audience of the size and enthusiasm which the fair will provide."

The Enterprise completed a four-week tour of Europe in May. A featured display at the Paris Air Show, it was also viewed by hundreds of thousands at stops in Bonn/Cologne, Rome, London and Ottawa. On its return home from the triumphal international tour, it was on display at Dulles International Airport in Washington, D.C.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
H. Douglas Garner, NASA/LaRC	Magnetic heading reference	4,418,480	LaRC
James M. Kendall, John V. Walsh, Caltech/JPL, Pasadena, Calif.	Pressure letdown methods and device for coal conversion systems	4,418,722	NRO-JPL
Dennis R. Hewitt, NASA/GSFC	Thermal control system	4,420,035	GSFC
James E. Schroeder, Paul J. Shlichta, Pasadena, Calif.	Absorbable-susceptor joining of ceramic surfaces	4,420,352	NRO-JPL
Lawrence L. Harper, International Laser Systems, Orlando, Fla.	Laser resonator	4,420,836	GSFC
Donald J. Progar, NASA/LaRC	Hotmelt recharge system	4,420,518	LaRC
Bhanu C. Patel, Rockwell International, Downey, Calif.	Method and technique for installing lightweight, fragile high-temperture fiber insulation	4,421,700	JSC
Henry G. Kosmahl, NASA/LeRC	Ladder supported ring bar circuit	4,422,012	LeRC
William E. Thornton, NASA/JSC	Method and apparatus for simulating gravitational forces on a living organism	4,421,109	JSC
Keith H. Clark, Donald R. Scott, NASA/MSFC	Electrical self-aligning connector	4,421,371	MSFC
Daniel D. Elleman, Arvid P. Croonquist, Taylor G. Wang, Caltech/JPL, Pasadena, Calif.	Acoustic rotation control	4,420,977	NRO-JPL
Indra K. Varma, George M. Fohlen, John A. Parker, National Research Council, Washington, D.C.	Elastomer-modified phosphorus-containing imide resins	4,421,820	ARC
Keith H. Clark, NASA/MSFC	Clamp-mount device	4,422,609	MSFC

NASA To Have Record Breaking 1984 Launch Schedule

NASA has a record-setting launch schedule set for 1984—10 Space Shuttle flights, 10 satellite deployments from the Space Shuttle in orbit and 12 unmanned missions using expendable launch vehicles.

The 10 Shuttle missions will be double the number of manned flights in any year of the agency's history. During the Gemini program, five manned missions were flown in both 1965 and 1966.

The launch activity will begin Feb. 3 with the launch of Shuttle mission 41-B using the orbiter Challenger. Two communications satellites will be deployed from 41-B—Westar-VI, for Western Union, and Palapa B-2 for the government of Indonesia. The eight-day mission will feature the first Shuttle landing at Kennedy Space Center in Florida; and the first flight of the Manned Maneuvering Unit, a self-contained, propulsive backpack that will allow astronauts to move about in space without being tethered to the spacecraft.

In March Landsat D', an earth observations satellite, will be launched for the National Oceanic and Atmospheric Administration (NOAA) from the Western Space and Missile Center, Vandenberg Air Force Base, Calif., aboard a Delta launch vehicle.

During the first quarter of 1984, Navy-21 will be launched on a Scout rocket from the Western Space and Missile Center for the Department of Defense.

Shuttle mission 41-C with orbiter Challenger is scheduled for April 4. The highlight of this six-day flight will be the repair of the Solar Maximum Mission satellite, launched Feb. 14, 1980, for scientific studies

of solar flare activities. The astronauts will perform a spacewalk to stabilize the spacecraft so it can be grappled by the remote manipulator system and berthed in the cargo bay for the repair operations.

Two unmanned missions are scheduled for May from the Eastern Space and Missile Center in Florida. Intelsat VA-A, a Intelsat international communications satellite, will be launched aboard an Atlas Centaur, and NATO-IIID, a North Atlantic Treaty Organization communications satellite, will be sent aloft on a Delta.

Space Shuttle Orbiter Discovery is scheduled to make its debut June 4 of flight 41-D. Payloads on this seven-day mission include the Large Format Camera and the Office of Aeronautics and Space Technology-1 (OAST-1) pallet, to conduct investigations in space technology. In addition, two communications satellites will be deployed—Telesat-I for Canada and Syncom IV-1 for Hughes.

In addition to the 41-D mission, Galaxy-C, a Hughes commercial communications satellite, will be launched in June from the Eastern Space and Missile Center aboard a Delta.

Shuttle flight 41-E using orbiter Challenger is a dedicated Department of Defense mission scheduled for July.

August will be NASA's busiest month with three unmanned missions, two Shuttle missions and three satellite deployments from the Shuttle. NOAA-F, a weather observations satellite, will be launched from the Western Space and Missile Center. Intelsat VA-B, a Intelsat communications satellite, will be carried aloft on an Atlas Centaur; and the Active Magnetospheric Particle Tracer Explorer (AMPTE), a space physics mission cooperative with the Federal Republic of Germany, will be launched on a Delta, both from the Eastern Space and Missile Center.

On Aug. 9, Shuttle mission 41-F, a seven-day flight with orbiter Discovery, will feature the first autoland at Edwards Air Force Base, Calif. Payloads on this flight include SPARTAN-1 (a new class of small astronomical payloads that would normally fly aboard a sounding rocket) and the deployment of three communications satellites: SBS-D, for Satellite Business Communications; Syncom IV-2, for Hughes; and Telstar 3-C, for AT&T.

Shuttle mission 41-G, a 10-day flight of orbiter Columbia, is slated for Aug. 30. The cargo includes OSTA-3, the Earth Radiation Budget Experiment (ERBE) and SPARX-1, a commercial remote sensing payload.

Navy-22, an unmanned mission for the Department of Defense, is scheduled for launch aboard a Scout vehicle from the Western Space and Missile Center during the third quarter of 1984.

Scheduled for Sept. 28 is Shuttle mission 41-H with orbiter Challenger. The payload for this mission will be either a dedicated DOD mission or the deployment of TDRS-B, the second in the series of three satellites in NASA's Tracking and Data Relay Satellite System.

Shuttle flight 51-A with orbiter Discovery is scheduled for Oct. 24. Payloads on this six-day mission will feature the Materials Science Laboratory, a self-contained facility to provide accommodations for experiments in the materials processing field; the GAS Bridge, a structure across the payload bay designed to hold additional Getaway Special canisters; and the deployment of Telesat-H, a Canadian communications satellite.

Shuttle mission 51-B, a seven-day flight of orbiter Challenger, will be launched on Nov. 21 with Spacelab 3 as its cargo. Spacelab 3 will be the first operational flight of the European-built laboratory.

Also scheduled for November is Intelsat VA-C, an international communications satellite for Intelsat, aboard an Atlas Centaur from the Eastern Space and Missile Center.

The Air Force has scheduled its unmanned AF-16 (ITV-1) aboard a Scout rocket from the Wallops Flight Facility, Wallops Island, Va., during the final quarter of 1984.

In December, San Marco D/L, an international cooperative project with Italy, will be sent aloft using a Scout launch vehicle from the San Marco Range off the coast of Kenya in the Indian Ocean.

Winding up the year on Dec. 17 is Shuttle mission 51-C with orbiter Discovery. The payload for this seven-day flight will be the Materials Science Laboratory-2 and either the TDRS-B or TDRS-C NASA communications satellite.

1984 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Mission Remarks
Feb. 3	41-B	Challenger	KSC	Payload: SPAS-01A, Palapa B-2, Westar-VI
April 4	41-C	Challenger	KSC	Payload: Solar Max Repair Mission; Long Duration Exposure Facility
June 4	41-D	Discovery	KSC	Payload: Telesat-I, Syncom IV-1, Large Format Camera, OAST-1; first flight of Discovery
July 14	41-E	Challenger	KSC	DOD mission
Aug. 9	41-F	Discovery	KSC	Payload: Telstar 3-C, SBS-D, Syncom IV-2, SPARTAN-1
Aug. 30	41-G	Columbia	KSC	Payload: OSTA-3, ERBS, SPARX-1
Sept. 28	41-H	Challenger	KSC	Payload DOD mission or TDRS-B
Oct. 24	51-A	Discovery	KSC	Payload: MLS-1, Telesat-H, GAS Bridge
Nov. 21	51-B	Challenger	KSC	Payload: Spacelab 3
Dec. 17	51-C	Discovery	KSC	Payload: TDRS-B or TDRS-C, MSL-2

Satellite Deployments from the Space Shuttle

Date	Mission	Launch Vehicle	Launch Site*	Mission Remarks
Feb. 3	Westar-VI	PAM-D	41-B	Western Union communications
Feb. 4	Palapa B-2	PAM-D	41-B	Indonesia communications
June 4	Telesat-I	PAM-D	41-D	Canadian communications
June 5	Syncom IV-1	PAM-D	41-D	Hughes commnications
Aug. 9	SBS-D	PAM-D	41-F	Satellite Business Systems commercial communications
Aug. 10	Syncom IV-2	PAM-D	41-F	Hughes communications
Aug. 11	Telstar 3-C	PAM-D	41-F	AT&T communications
Sept. 28	TDRS-B(?)	IUS	41-H	NASA communications
Oct. 24	Telesat-H	PAM-D	51-A	Canadian communications
Dec. 17	TDRS B or C	IUS	51-C	NASA communications

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site*	Mission Remarks
March	Landsat D'	Delta	WSMC	NOAA earth observation; reimbursable
1st Qtr	Navy-21	Scout	WSMC	Navy; reimbursable
May	Intelsat VA-A	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
May	NATO-IIID	Delta	ESMC	North Atlantic Treaty Organization communications; reimbursable
June	Galaxy-C	Delta	ESMC	Hughes commercial communications; reimbursable
August	NOAA-F	Atlas-F	WSMC	NOAA weather satellite; reimbursable
August	Intelsat VA-B	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
Aug. 9	AMPTE	Delta	ESMC	Active Magnetospheric Particle Tracer Explorer; space physics—NASA cooperative with Germany
3rd Qtr.	Navy-22	Scout	WSMC	Navy; reimbursable
November	Intelsat VA-C	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
December	San Marco D/L	Scout	SMR	International cooperative with Italy
4th Qtr.	AF-16 (ITV-1)	Scout	WFF	Air Force; reimbursable

* Launch Sites
ESMC—Eastern Space and Missile Center, Fla; KSC—Kennedy Space Center, Fla; SMR—San Marco Range, Indian Ocean; Space Shuttle Orbiter Challenger: 41-B, 41-C, 41-E, 41-H, 51-B; Space Shuttle Orbiter Columbia: 41-G; Space Shuttle Orbiter Discovery: 41-D, 41-F, 51-A, 51-C; WFF—Wallops Flight Facility, Wallops Island, Va.; WSMC—Western Space and Missile Center, Vandenberg Air Force Base, Calif.

NASA Telepresence Study Expands Activities In Space

It is 1999, and in the black vacuum of space, a lone figure on a rescue mission maneuvers away from a spacecraft and reaches out to a malfunctioning satellite. One hand twists a knob that releases a protective metal plate from its latchings. Another hand removes the plate exposing the electronic problem that disabled the satellite, while a third hand steadies the satellite so that repair can be made.

A third hand?

A third human hand? Actually, no. All three hands, with flexibility and strength far beyond human capabilities, are attached to a highly complex robot, directed moment to moment by a human operator hundreds of miles away on earth.

It is 1999 and robotic satellite repairers have become commonplace in space—part of an exotic field of automation called "telepresence".

Such scenarios as this are not entirely the stuff of science fiction. Recently the Massachusetts Institute of Technology issued its final report on a year-long study of telepresence for NASA's Marshall Space Flight Center, Huntsville, Ala.

Telepresence is a concept in which a human being—with sensors attached to his body and by moving his head, arms, and legs—could direct the motions of a robotic device, located far away, to carry out humanlike activities.

For example, a driver strapped into a remote control device in New York could maneuver an empty automobile through Los Angeles. By the action of turning his head left or right, the "driver" would cause a camera in the Los Angeles vehicle to turn left or right, thus allowing the driver to see what the camera sees—just as if he were actually seated in the car.

By moving his legs and arms, the driver could also steer, accelerate, and brake. "And it would be the same way in space," said NASA's Georg von Tiesenhausen, study manager of robotics in the Advanced Systems Office. "With telepresence, you could do things in space as if you were really there."

The MIT study was actually a two-part effort. The first dealt with robotics and addressed three areas: the kinds of activities expected in space over the next 15 years, the state of the art of automation expected over the same period, and the matching of each activity with the automation available. The second part of the study dealt with the robotics-related field of telepresence.

"The institute considered concepts for both the near, intermediate- and far-term future," said von Tiesenhausen, "and the study concentrated on the near term. These periods of time are highly subjective, of course, but generally 'near term' means around the mid- to late-1980s, 'intermediate' around the early 1990s, and 'far' about the end of this century."

For the near term, MIT examined telepresence in regard to extravehicular activities, or "EVA," during which a suited astronaut works outside a space vehicle. "We want to be able to match the human capabilities of EVA with the mechanical capabilities of telepresence using only current technology," said von Tiesenhausen.

"We hope to have a flight test aboard the Space Shuttle and use a machine with robotic arms in the payload bay. The robotic machine might manipulate a test board—a flat display with various mechanical parts land we could study some basic telepresence activities."

Von Tiesenhausen explained why telepresence is superior to EVA. "If an astronaut wants to go outside the spacecraft, he has to suit up. That takes time. Furthermore, he has to 'pre-breathe' which takes more time. And then you have to consider that astronauts tire. A machine doesn't. Finally, telepresence is safer.

"We believe that telepresence capabilities will be at least equal to human EVA abilities by the 1990s.

"The MIT study examined the needs of continually improving a human operator's electronic vision when using a telepresence machine," said von Tiesenhausen. "Telepresence requires a huge number of communication bands, each linking a specific command from the human body to the machine. The more complex the requirements of vision and touch, the heavier the communication requirements. It's a problem, because there are only so many bands we can use.

"For the near term, for example, we're going to use black-and-white stereo television cameras on the robotics machine to enable the human operator to see well enough to have a sense of 'being there.' The images produced by those cameras, however, are inferior to images produced by human eyesight. By the intermediate term we hope to match the capability of human eyesight. But to see in color and have a wide field of view requires a far higher number of communication bands.

"Another aspect of the human eye is its ability to concentrate resolution in the center of the field of the view. At present, television cameras can't do that, but that's another capability we're seeking by the intermediate term. And that capability will require even more communication bands."

For telepresence vision at the end of the century, the study recommends aspects of eyesight that exceed human capability.

In addition to the improvement of sight capability, the MIT study addressed the need for continued evolution in the telepresence sense of touch. In the near term, an operator will rely only upon his eyesight to grasp an object with the handlike grappling device on the end of a robotic arm.

By the intermediate term this handlike device, often called an end effector, may match human capabilities by the use of proximity and force-feedback sensors.

"A proximity sensor," explained von Tiesenhausen, "could generate a tone at the operator's station as the robotic hand approached an object. The closer the end effector came to its target, the higher the tone would rise, eventually to a high squeal. When the end effector finally grasped the object, the tone would cease. In addition to direct targeting, the tone would provide an excellent means to avoid collision with something when the robotic arm went behind an object, out of view of the operator.

"After the tone stopped, the force-feedback sensor would take over. It would send a message to the operator—one he could actually feel in his own hand on the amount of force needed to grasp the object. Some instruments to be handled might be very delicate and require little force to manipulate, while other equipment would require a stronger hold.

"We anticipate that force-feedback sensors will also have the ability to send back messages as to whether the object is hot or cold, whether its texture is rough or smooth, or even if it's a certain shape, like round or square.

"In the far term, however, we want the end effectors to exceed the ability of the human hand. We would also like to employ more than two robotic arms in a telepresence machine. That naturally presents a problem, since a human operator would move two robotic arms by telepresence with each of his own arms. How to control a third robotic arm presents a real challenge. A third arm could grasp and hold an object while the other two arms performed maintenance upon it."

Von Tiesenhausen foresees telepresence machines advancing not only in manipulative skills but in artificial intelligence as well.

Although this MIT study has concluded, the possibilities which telepresence offers will probably continue to be explored over the next several years, according to von Tiesenhausen.

Laser Systems To Study Italian Earthquakes

NASA and the National Space Plan of the National Research Council of Italy recently inaugurated a satellite laser ranging station near the city of Matera in southern Italy for the study of plate tectonics and earthquakes. Laser ranging, initially developed by NASA for precise tracking of satellites, provides a means for measuring the distance between points located on different plates, to within a few centimeters.

Under a 1982 agreement with NASA, the Italian government constructed the Matera station and installed a laser and associated optical and electronic systems which are on loan to Italy from NASA. Data acquired by the station will be provided to NASA and the international scientific community.

The Matera station will range to specially equipped satellites such as the NASA Laser Geodynamics Satellite (Lageos) and the French Starlette Satellite. The Italian laser will work with other satellite laser stations in Europe, the United States, Australia, and the Far East to acquire data on the movement of the large tectonic plates which make up the earth's crustal layer.

The earth's crustal layer is broken into a number of large plates which move in relation to one another at rates from a few centimeters, to as many as 15 centimeters per year. The mechanism that forces the plates to move is unclear. Historical data, however, indicates that this movement is part of a continual process of the generation of an oceanic crust and the accretion of the continents.

Most earthquakes occur near the boundaries where the plates collide. To understand how the plates move and how the crust is deformed by this movement, it is important to understand why earthquakes occur.

At a laser station, a short pulse of coherent light with a duration of a few billionths of a second is bounced off a satellite equipped with corner cube retroreflectors. The travel time of the pulse is accurately measured to determine the location of the station and the distance between stations. By acquiring data over a period of time, the change in distance can be determined and used to calculate the velocity and direction of the motion of one plate with respect to another. A fixed station can also work with mobile laser systems to map changes near plate boundaries to determine how and where crustal strain is accumulating. Earthquakes occur when strain energy is sufficient to cause the crust to fracture.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Fabric Structures

Architects, engineers and building owners are turning increasingly to fabric structures because of their aesthetic appeal, relatively low initial cost, low maintenance outlays, enrgy efficiency and good space utilization.

Fabric structures have long been used as temporary shelters, but their use as permanent alternatives to conventional buildings has grown markedly in the past decade, spurred by the availability of advanced materials, an aerospace spinoff from NASA research in its quest for new fabrics for astronaut space suits.

The accompanying photos are examples of U.S. structures whose roof coverings are made of Teflon®-coated Fiberglas® fabric.

Below is Bullock's Department Store, San Jose, Calif., which has an 18,000-square-foot light-transmitting fabric roof covering the center third of the store's upper level.

Perhaps the best known of all fabric structures, by virtue of its television exposure, is the Silverdome in Pontiac, Mich., home of the National Football League's Detroit Lions (above).

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